Senior High School

CURRICULUM GUIDE

Vocational Series

DRAFTING 12 - 22 - 32

(Revised Edition, September, 1965)

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Province of Alberta

Department of Education

CURRGDHT

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COURSE CREDIT VALUES

Drafting 12 . . . . . 5 credits

Drafting 22 . . . . . 15 credits

Drafting 32 . . . . . 15 or 20 credits

One credit corresponds to a minimum of 40 minutes of instruction time per week.

INTRODUCTION

This curriculum guide has been prepared for Alberta high schools teaching vocational Drafting.

Instructors of this subject should endeavor to follow this guide closely in order to facilitate, as much as possible, Province-wide standardization, thus enabling students to transfer from centre to centre and continue with their course with a minimum of adjustment.

It is hoped that this guide will prove to be of assistance and will be used extensively by drafting instructors.

OBJECTIVES

The general objectives of the vocational drafting course are as follows:

1. Adequately prepare a student to the level where he will be successfully employable in the drafting industry.

2. Prepare a student to a degree of competency acceptable to the Institute of Technology and Art for entrance into their second year of Drafting Technology or Architectual Technology Course.

3. Supply those not necessarily interested in drafting as a vocation, with enough skills so that they may use their knowledge of drafting and blue print reading in one of the related fields, i.e., estimating, etc.

4. To assist in developing the personality of the student so that he will be a reliable, industrious, cooperative, socially acceptable adult; and to retard any personal traits that would be detrimental to the individual as an employee or fellow worker.

5. To assist the student in being able to read, appraise, understand and use material written in a technical language.

6. To develop a systematic approach to solving problems similar to the type likely to be found in industry.

GENERAL INFORMATION

1. Course Credit Values

Drafting 12 - 5 credits
Drafting 22 - 15 credits
Drafting 32 - 15 or 20 credits

NOTE: Drafting 22 includes 5 credits of machine shop and 5 credits of building construction.
(Drafting 32 outline will not be available until 1964)

2. Instructors' Records

The instructor should keep accurate records of:

a. student enrolment and attendance
b. students' accounts
c. student work
d. theory taught
e. tests given
f. student achievement
g. up-to-date inventory of all equipment

3. Students' Records

Instructors should ensure that the student develops and maintains a neat and accurate record of:

a. notes on theory
b. daily shop or drafting activities (time cards)

4. Guidance and Vocational Information

Instructors must assume responsibility in their trade area to ensure that students and school guidance officials are aware of the local situation. It is essential that the instructors be active, interested and informed regarding the opportunities in the trade.

NOTE: In order to permit students from an academic Grade X program to cross over into the vocational program at the Grade XI level, schools may combine the 12 and 22 courses into one course for a total of 20 credits. Where these courses are combined it is recommended that students purchase the Grade XI text only.

NOTE ALSO: Whereas Drafting 12 is an exploratory course open to all Grade X students, the Drafting 22 and 32 courses are definitely vocational and only those students who have displayed ability and aptitude for the program should be encouraged to continue. It is not fair to the student to permit him to continue in a program which demands a large portion of his school time, and in which the instructor and/or the guidance counsellor feel that he has little chance of success.

OBJECTIVES OF THE GRADE TEN YEAR

The grade ten year should be considered to be an exploratory year during which the students would investigate drafting in a general way. This should enable them to make an informed decision in regard to continuing drafting as a vocational subject in Grade XI and XII.

The more specific objectives for the grade ten year are as follows:

1. To create a desire for proficiency and accuracy in both drafting and related theory.

2. Develop habits of neatness, cleanliness and orderliness in work situations.

3. Become aware of positions and employment opportunities in the drafting industry.

4. Understand the importance of drafting, related technical skills, and knowledge in an industrial nation.

5. Develop working skills and knowledge in the following areas of study:

   (a) Lettering

   (b) Sketching

   (c) Use and care of instruments

   (d) Layout

   (e) Orthographic projection

   (f) Scale drawing

   (g) Dimensioning

   (h) Isometric drawing

   (i) Oblique projection

It should be clearly understood that high standards of draftsmanship must be developed and maintained at all times. It is felt that this will make the above mentioned objectives more easily obtainable and the course more meaningful to the students.

Instructions on the Use of the Following Guide

The pages of the following guide are divided into three columns marked: Basic Information, Operations and Projects, and References. The first column might be considered as information that must be covered by the instructor in class. The second cclumn is a guide to the student's activities. This covers explicit operations and skills that the student must master. The third column refers to places in various reference books that the instructor should become familiar with in order to successfully present the required information. These books are recommended for drafting room reference.

The code for this reference section is as follows: The letter prefix indicates the reference book. The number series following it indicates the page number followed by a comma. The next series indicates the paragraph number. In some cases, a figure number may be given. This is denoted by a figure as a prefix, i.e., G P.123,173 would mean Giesecke, page 123, paragraph 173.

The Reference Books are coded as follows:

A — Almon, Basic Mechanical Drawing, Bruce

C. S. A. — Canadian Standards Association, Mechanical Engineering Drawing Standards, B78.1

C.G.S.B. — Canadian Government Specifications Board, Architectural Drawing Practices, 33-GP-7

F — French and Vierck, Engineering Drawing, 9th edition. McGraw Hill Book Company, New York. (Canadian representative - McGraw Hill Book Company of Canada Limited, Toronto, Ontario)

F S — French and Svenson, Mechanical Drawing, and problem sheets, Levens and Edstrom, Pts. 1 and 2

G Giesecke, Mitchell and Spencer, Technical Drawing, 4th edition. Macmillan Company, New York. Canadian representative - Brett-Macmillan Company, Galt, Ontario.

M McLaughlin, Montieth, Tarry, Torney, A Course of Study in Drafting for Canadian High Schools, Tyrell Press, 80 Lebreton Street, Ottawa 1, Ontario.

Z Zozzora, Engineering Drawing, McGraw-Hill Book Company, New York. Canadian representative - McGraw-Hill Book Company of Canada Limited, Toronto, Ontario.

In the event of conflict between texts, the C.S.A. and C.G.S.B. manuals will be the final authority.

The projects that are listed are to be used merely as a guide to present some standard of accomplishment throughout the province. Individual instructors may select other projects of similar nature but that would demand an equal effort from the student than those suggested in the guide.

The recommended text for Grade X is McLaughlin et al, A Course of Study in Drafting for Canadian High Schools.

Basic Information	Operations and Projects	References
	Unit One: Introduction	
General class organization, issuing of supplies and equipment, introduction of drafting as the language of the industrial and technical world, overview of course and standards expected.	Student should begin notebook with place for Glossary of terms.	
	Unit Two: Instruments and Materials	
Introduction to the tools; compasses, dividers, spring bows, T-square, set squares (30°-60°-45°), scales, erasers, erasing shields, sanding block, drafting tape, drawing papers, etc. Care and storage of equipment.		FP18, 2.2-2.4, 2.9-2.11, 2.14, 2.15, 2.18-- Z.P. 56 4-1 P. 57 4-5 to 4-9 P.64 4-19 to 4-24
	Unit Three: Use of Instruments	
Board requirements. Fastening paper to board. Construction and use of T-square, test for accuracy. Methods of sharpening pencils. Correct methods of drawing lines, etc. Use of protractor, compass, dividers, scale (1/16 inch divisions), erasing shield,	Stress correct use of instruments. Mounting paper, border, title block, etc. Horizontal lines, vertical lines, angles of 15 multiples using both triangles. Drawing parallel lines with set squares. Dividing a line or space by parallel line	F P29 2.25 to 2.34, P41 2.39, 2.42, 2.43 M.P. 2,3,13,14 15,39 Z.P. 56 4.1, 4.6 to 4-14 P. 65 4.21 to

Basic Information	Operations and Projects	References
etc. Alphabet of lines, sizes of drawings. (A.S.A.)	method. Drawing of different types of lines, circles, arcs, tangents. Construction lines, center lines, hidden lines, outlines, order of drawing and darkening. Suggested Projects: F - P47 fig. 2.5.1, 2.5.2. G - P.60 Fig. 94 P 61 fig. 96 or some of fig. 97. P.62 Fig. 99 M - P.84-85 fig. D101 to 104. P.89 fig. D118-123 (do not dimension) G - P.90 fig. 5-11, 5-15	4.24 P.67 4.26, 4.27

Unit Four: Lettering

Importance of lettering in drafting. Forms of Alphabets and their use. Caps and lower case. Compressed, normal and extended lettering. General proportions, order of strokes and composition. Lettering must be taught	Single stroke upper case Gothic lettering. Students should become proficient with 1/8", 1/4" and 3/8" lettering, centering of titles and title blocks, etc. Lettering on the face of drawings shall be 1/8" vertical, single stroke Gothic.	F P.79, 4.1 to 4.9 G P.64, 75 to 84 P.70, 86 to 94 P.8, 2.5 to 2.15 M P.4

Basic Information	Operations and Projects	References
and checked all during the year.	Suggested Projects 2 plates 8½x11 to include alphabets, numerals, fractions, words, phrases, etc. in three sizes 1/8", 1/4" and 3/8". Vertical single stroke Gothic.	Z Chap. 1 except lettering devices.

Unit Five: Geometrical Construction

Terms; points, lines, angles, triangles, quadrilaterals, polygons, circles, arcs, tangents, etc. The draftsmans method of drawing these should be demonstrated and stressed.	Bisection of a line, arc, angle. Construction of a line through a point parallel to a given line.	F P.56, 3.19, 3.27 G P.90, 107-120
	The construction of a line parallel to a given line at a given distance from it.	Z P.71, 5.1, 5.2 F P.51, 3.22
	The division of a line into equal parts. The construction of a line through a point perpendicular to a given line. The construction of a triangle with given sides.	Z P.71, 5.4, 5.5 F P.52, 3.4 Z P.71, 5.3 F P.58, 3.29 Z P.72, 5.7
Applications of geometric construction.	The construction of a square. The construction of a hexagon. across corners and across flats. The construction of a circle through three points not in a straight line.	Z P.72, 5.6 F P.59, 3.33 Z P.72, 5.9 F P.60, 3.38 Z P.75, 5.14

Basic Information	Operations and Projects	References
	The construction of a circle tangent to a line at a given point. The construction of tangent arcs:	F P.53, 3.7
	a) to two lines at right angles.	F P.54, 3.11 Z P.76, 5.19
	b) to two lines at acute or obtuse angles.	F P.54, 3.12 Z P.77, 5.20
	c) to an arc and a straight line.	F P.54, 3.15 Z P.78, 5.22

Unit Six: The Theory of Projection Drawing

This should be considered as an introductory unit, stressing the following:

1. Drawings are necessary in the industrial world to record, express and convey ideas and information, necessary for the construction and erection of machines and structures.
2. There are different methods of drawing the representation of an object.
3. It is difficult to draw things accurately and at the same time make them appear as real objects.

Basic Information	Operations and Projects	References
4. Standard ways of representing objects are necessary for universal understanding of the representation. The instruction should show examples of: a) single point perspective b) two point perspective c) three point perspective d) isometric e) cabinet f) cavalier g) orthographic This section is to lead up to the next unit; orthographic projection.		

Unit Seven: Orthographic Projection

1. Introduction-orthographic true shape.	Laying out and drawing of simple two and three view drawings. The instructor should select suitable objects or projects out of McLaughlin pages 86, 87 and 88 and more difficult work from pages 91, 95, 96 and 100. The instructor may also use self devised blocks and job sheets for better visualization by the students.	M P.9 G P.161-62
2. Views of an object, glass box; arrangement of views. The C.S.A. layout of views one, two, and three view drawings. (Familiar with alternate view drawings, position of views, partial views.) How to balance 2 view drawing and 3 view drawing.		M P.10 M P.11 M P.14-15 G P.164, 211 Fig. 292

Basic Information	Operations and Projects	References
3. Hidden lines, the meaning of lines, the precedence of lines.	Drawings of objects may be selected from Giesecke, pages 190 to 200. The instructor should always keep in mind student interest when	
4. Transferring depth measurements.		
5. Visualization-interpretation of views.	selecting the drawings to be drawn by the student covering all the forementioned points under Basic Information. Sketching should be included as project work.	G P.224-276 G P.224, 225, 226
6. Surfaces, edges, corners, normal surfaces and edges, inclined surfaces, oblique surfaces.		G P.227, 228, 229
7. Scale drawings.		
8. Orthographic sketching.		
(See Unit XI)		

Unit Eight: Dimensioning

Introduction		McL P.17-23
a) Size description.		G P.298, 328
b) Scale of drawings.		G P.299, 329
c) Lines used in dimensioning.	1. Dimensioning problems from the text.	G P.310, 331
d) Placement of dimension and extension lines.	2. Problem sheets - could be made up and have the pupils place the proper dimensions.	G P.301, 332
e) Arrowheads and leaders.		G P.302-3, 533-4
f) Fractional and decimal dimensioning.		G P.303-4, 335
g) The lettering and reading of dimensional figures.	The previous units can be dimensioned, after all the factors in dimensioning have been covered.	G P.304-5; 336 G P.305-6, 338 G P.306-7; 339

Basic Information	Operations and Projects	References
h) Symbols for feet and inches.		
i) Dimensioning, angles, arcs, fillets and rounds.		P.340, 341
j) Size dimensioning of holes.		G P.313, 349

Unit Nine: Isometric Drawing

G P.482 Fig. 823

Student should draw a number of simple isometric drawings, as outlined in pages 114-5 of McLaughlin and/or pages 510-513 of Giesecke. The instructor when selecting drawings, should always keep in mind the points under Basic Information and student interest.

Sketching should be included as project work.

1. Isometric drawing.		G P.483, 450 Fig. 825
a. The position of isometric axes.		G P.452-3 Fig. 826
b. Offset location measurements.		M P.47
c. Hidden lines in isometric drawings.		G P.485, 453 Fig. 829
d. Centre lines.		G P.485-6
e. Box construction.		G P.454 Fig. 832-3
f. Non-isometric lines.		G P.486, 456
g. Isometric dimensioning.		G P.486, 457, Fig. 835
h. The use of isometric drawings in industries.		M P.48
		G P.489, 458 Fig. 836
		G P.487, 469 Fig. 857a
		G P.487, 469 Fig. 857a and 858

Basic Information	Operations and Projects	References

Unit Ten: Oblique Projection

1. Types of oblique projection. a. Cabinet projection. b. Cavalier.	Drafting jobs on oblique projection may be chosen from McLaughlin, pages 136-7 or, and Giesecke, pages 526-28.	McL P50 G P.516, 482 McL P.50 Mcl P.50-51
2. The choice of position of the object.		G P.519, 485 Fig. 884-5
3. The steps followed.		G P.519, 486 Fig. 886
4. Dimensioning an oblique drawing.		McL P.51
5. Sketching in oblique.		G P.524, 491 Fig. 895

NOTE: Student should make drawings of the same object by each of the oblique above methods of projection.

Unit Eleven: Technical Sketching

Value of technical sketching.	M P.10
A means of expression of ideas that are difficult to put in words. A simple and quick means of expressing an idea. (Thinking with a pencil.)	G P.129-130
Sketching materials.	G P.130
Pencil H, HB	M P.10-11
Eraser	Z P.42
Paper: plain white, squared, isometric, thin paper placed over dark lined squared or	

Basic Information	Operations and Projects	References
isometric paper.		
Line technique.		
Outline Dimension line. Invisible line.	Draw several drawings requiring various types of lines. It would be desirable to use several of the types of paper listed in column one.	G P.130-131-132 Z P.44-45
Circles, arcs and ellipses		
Blocking in circles. Use of radial lines. Use of squared paper to draw circles. Isometric paper and ellipses.	One exercise in freehand drawing of curved lines, circles and ellipses. Make use of models available in the classroom. Also choose one figure that contains some of the above from Zozzora, pages 52-55. Students should make sketches of many of the drawings they will complete at a later date.	Z P.47

Unit Twelve: Primary Auxiliary Views

Primary auxiliary view.		
This is a view projected to a plane perpendicular to one of the three principal planes; front, top or side and inclined to the other two.		Z P.167 Z P.168 Fig. 9.1

Basic Information	Operations and Projects	References
How to draw an auxiliary view.		
How to draw a reference line parallel to the edge of a view. The reference line can be considered a folding line.	Draw an object similar to the one shown. Use classroom models as samples for auxiliary views.	Z P.121 Fig. 9.7
The reference line is used to locate points on the auxiliary view.	See also McLaughlin P. 43-44.	G P.235 Fig. 472
The convenience and accuracy gained when the reference line is passed through a plane or points of the object itself.		
Construction of auxiliary views.		
(simple objects) Procedure for simple auxiliary views.	One drawing of a very simple object.	Z P.173 Fig. 9.9
Partial auxiliary views.		
The practice of showing only the shape and details of the inclined surface and not a view of the entire surface.		Z P.173 G P.242
Auxiliary view to complete a principal view.		
A situation is often encountered where an auxiliary view is necessary to complete other views.	One drawing of a simple object where partial auxiliary views may also be used on the same drawing.	Z P.173
Know the procedure of		Z P. 173 Fig. 9.10

Basic Information	Operations and Projects	References
showing the inclined plane as an edge to construct a principal view.		
True length of line.		
True length of line seen only on a plane of projection.		Z P.174 Z P.175 Fig. 9.13

Unit Thirteen: Sections

Full Sections		
A longitudinal line extending through an entire object.		Z P.141 M P.28 G P.207
Cutting Plane		
A portion of an object nearest the observer that has been removed by means of a cutting plane to reveal section lines and arrows.	Draw a simple section from a model or from examples in Z, pages 33, 34, 35, 36.	M P.28 G P.210 Z P.141, 8.2
Offset Sections		
Placing the cutting line through other than the main axis so that it shows direct features and details.		M P.32 Z P.142 8.3 G P.217-255
Section Lining		
A method of distinguishing sections by lining. The drawing of parallel lines	Draw a simple full section. Examples may be a section of pipe, bearing or flange.	Z 142 G P. 208-209 M P.29

Basic Information	Operations and Projects	References
across all surfaces cut.	Students should do several simple drawings to develop some skill. One drawing should be of such a nature that special angle lines need be used.	
Section lining technique.		
Proper line angle for good contrast.	A simple drawing that must be lined at a special angle.	G P.209 Z P.143 8.8
Use of symbolic section lining.	Include a drawing lined to indicate material. This could be a drawing of standards used, etc.	M P.29
Visualizing a section.		
Make use of drawing in text. Use mockups made of wood.		M P.33-34 G P.211, 249
Breaks and ribs in sections.		
When cutting plane cuts flatwise through a web gear tooth or flat element a false impression of solidity should be avoided. The flat rib should not be sectioned.	Any one of the above drawings could contain a rib or webb.	G P.218-223 Z P.151 8.22
Kinds of section.		
Half	If time permits.	
A symmetrical object drawn so that only half of it is sectioned. One	One simple drawing that could contain several of these sections.	M P.30 Z P.146, 8.12 G P.21A

Basic Information	Operations and Projects	References
side of the centerline only.		
Broken Out		
A section drawn not indicating the cutting plane used only to show some isolated detail.	Show one isolated section of one of the above drawings.	M P.32 Z P.146, 8.13 G P.21A
Removed		
Sections drawn similar to revolved except they are placed outside or at one side of the drawing.		M P.31 Z P.149, 8.17 G P.217 F P.28-29
Revolved		
The imaginary cutting plane is passed through the object perpendicular to the horizontal axis and revolved on its center 90 into the paper.	One of the above drawings might be repeated to show the revolved section more clearly.	M P.31 Z P.148, 8.14

Unit Fourteen: Reproduction of Drawings

Tracing Media		
The selection of tracing papers. Test the ability of the paper to take ink, pencil, erasing, re-inking, smooth or rough line, etc. Tendancy of paper to discolor and become brittle.	Students should be able to observe the transparencies of the various papers. A demonstration with various papers would be excellent, pointing out the value of rag content.	Z P.383

Basic Information	Operations and Projects	References
Tracing cloth and its use because of durability and permanency. Good for ink and pencil. Shiny and dull side. Plastic.	Demonstration.	Z P.384
Tracing Instruments		
Methods of filling pen. Adjustment, proper use of pen.	Demonstration on filling and adjustment of pen for proper line. Demonstration in how to hold the pen and also use of special pens and pencils. Have students follow the demonstrations and synchronize adjustments to their instruments with that of the instructor.	Z P.385 Z P.386 Z P.389
Other types of pens used for producing a tracing.		
Inks, see local reproducing company.		
Reproductions		
Blueprint Process		
Demonstrations or lecture on methods of reproduction depending on the equipment available to the school or in the school. Blueprint papers are sensitized by applying a coat of potassium		G P.764

Basic Information	Operations and Projects	References
ferricyanide and ferric ammonium citrate. Care of this paper.		G P.765
Diazo Prints		
A process based on light-sensitive diazo compounds, advantages of this printing process.	Students should do at least one print using this process if equipment is available.	
Reproduction Quality		
Demonstration and lecture of what to look for in good prints. Recognize poor prints due to poor tracings, paper quality, over and under exposure.		
Photostat Prints		
A negative made of any drawing or tracing to any desired reduction or enlargement through the use of a special camera.	Observe a sample if available. Discuss advantages.	F P.371
Thermofax, verifax, xerography microfilming and the electrolatic process. Lithography.	Know the basic general theory of each process. To be able to recognize the difference between these by observation.	

Basic Information	Operations and Projects	References

Unit Fifteen: Blue Print Reading

The term applies to the reading of the language from the drawings of others. The students should be able to interpret the ideas expressed on technical drawings.

Project - Have the student read or interpret a drawing from the files or text. This could be in the form of a written assignment.

Ask for some oral interpretation for confirmation of students understanding. Have students study fellow students drawings or special file drawings to observe errors that have been made.

DRAFTING 22

(Second year of high school drafting)

Objectives for Drafting 22

1. To develop in the student an appreciation of craftsmanship in the field of drafting and promote a desire to attain a high degree of drafting skill and understanding.

2. To develop the ability to work in an orderly and efficient manner.

3. To develop skills in lettering, mechanical drawing and sketching.

4. To provide practical knowledge and experience in the field of metalworking.

Drafting 22 consists of:

Part I - Drafting - 10 credits

Part II - Metalworking - 5 credits

Part One - Drafting

Text: French and Svensen, Mechanical Drawing (Toronto: McGraw-Hill Book Co., Ltd.)

Note: Unit V "Dimensioning", is applicable to most other units and should be taught in conjunction with them.

UNIT I - LETTERING

Basic Information	Operations and Projects	References
A. Gothic capitals, numerals and fractions. Freehand Vertical		F&S Chpt. 3
1. Form and proportion.	Use of cross-section paper or ruled squares (perhaps $\frac{1}{2}$" of 3/4") for practice in forming letters of proper Gothic form, correct height in relation to width, and approved sequence of strokes. Use C.S.A. alphabet.	F&S p. 40
2. Order of strokes.		G p. 76
		C.S.A.
3. Uniformity in form, slope, height and stroke. Strokes dark, sharp, definite and of approved width.	Lettering practice. Use thin faint guide lines for $\frac{1}{4}$" and 1/8 " letters and numerals. Students should have lettering instruments to make guide lines.	F&S pp.374-7
		G. pp. 70-76
4. Fractions. Heights of fraction in relation to whole number. Fraction bar is not oblique. Figures do not touch fraction bar.	Practice for height and proportion in fractions and proper placement and alignment of fraction bar.	F&S p. 41
		C.S.A. B78.1
		G pp. 77-78
5. Spacing letters and words.	Lettering words and sentences 3/8", $\frac{1}{4}$", 1/8" high. Stress the importance of careful and extensive practice.	F&S p. 43
		G. p. 81
6. Simple titles and title blocks.	Learn and apply methods of centering words and phrases through practice exercises. A suggested assignment is the designing of a title page for drafting notes and assignments.	F&S p. 378
		G pp. 82-83
	Apply lettering practice to simple title blocks or title strips and devise one suitable for most of the drawings.	F&S p. 359

Basic Information	Operations and Projects	References
7. Meaning of "lightface" and "boldface" lettering. 8. Compressed and extended letters.	Return to short lettering practice exercises during the term. Later assignments should include information and practice in applying "lightface" and "boldface" lettering, and compressed and extended letters.	

UNIT II - INSTRUMENTS AND MATERIALS

Basic Information	Operations and Projects	References
A. Scales		
1. Types-Discuss and demonstrate the three basic types (Arch., Mech. Eng., and Civil Eng.) with the uses of each.		F&S p.26, 2.17 to p.30,2.25 Z p. 62, 4.15 to p.64, 4.18
2. Use of Commonly Accepted Scales. These are: Architect: 1/8" = 1'-0" 1/4" = 1'-0" 3/4" = 1'-0" 1½" = 1'-0" 3" = 1'-0" Mechanical Engineer: full size half size quarter size eighth size Civil Engineer: 10 20 40 50	Scale a number of given lines using the various types of scales when the lines are drawn to various scales. Draw a number of lines of given length to various scales. Start with full size scale and introduce others. F&S, p.373, prob. A.21 & A.22 and p. 374, prob. A.23 are good exercises in the use of the scale.	F p.32, 2.29 to p.34, 2.30
3. Scale shapes and materials: Triangular Flat-single bevel Flat-double bevel Box wood Box wood with plastic facing All plastic		
4. Methods of Division Open divided Close (or chain) divided		

Basic Information	Operations and Projects	Reference
B. Pencils		
1. Hardness and grade from 7B (softest) to 9H (hardest)	Students should purchase soft, medium and hard pencils. Other grades can be circulated in the class if desired.	F&S p.18 Z p.58,4.6
2. Quality-drafting pencils generally high quality		
3. Composition-standard pencil (graphite and clay); combination of graphite and plastic; all plastic. Where used.	Demonstrate advantages and disadvantages of various compositions of pencil on various surfaces.	
4. Points and Sharpening. Sharpening with pen knife and with draftsman's sharpener and screw driver. Shaping conical and chisel point.	Demonstrate pen knife procedure and insure throughout the course that students keep pencils sharp and clean.	F&S p.18,(2.5) Z p.42, 3.3 G p.18
5. Mechanical Pencils - point out availability, construction, grades of lead.		F&S p. 33, 2.28-2.33
C. Compasses:		
1. Adjusting and using compass.	Draw 1 plate of circles of specified sizes.	
2. Adjusting and using bow instruments.		
3. The drop compass.	Problems A-14 to A-20 text or other similar problems may be assigned as the use of the instruments involved is taught.	
4. The beam compass.		
5. Sharpening the lead.		
6. Adjusting and care of the pen.		
D. Dividers:	Demonstrate correct operations carefully.	F&S p.30, 2.26
1. adjustment	Divide given lines and arcs into equal spaces.	
2. transferring lengths	Transfer measurements from one simple drawing to another in	
3. dividing lengths	combination with T-square and triangle practice.	

Basic Information	Operations and Projects	References
E. Parallel Ruling Devices		
1. T-square - Materials (wood, plastic, metal, individual and in combination); testing of; care of; correct use.	Students should start with problems involving T-square and triangles, then advance to combination with "case instruments". Suggested Projects - F&S, p.361 ff, Problems A.1 to A.6, A.13 to A.16 for staight line work, and Problems A.6 to A.8, A.11 and A.17 for combined straight and curved lines. Problem A.23, p.374 involves scale and triangles.	F&S p.19,2.7 to p.25,2.16
2. Parallel Rule, (cable type) testing of; care of; correct use.		
3. Drafting machines. Types (band, parallelogram, rail mounted); adjustments; care; correct use.		
4. Straight edges - types and uses.		
5. Triangles, fixed. Shapes (2 basic); materials (wood, metal, plastic) testing, trueing, use of	Suitable projects may be found in all reference books.	
6. Adjustable triangles advantages and disadvantages, use of.		
F. Irregular and Flexible Curves	Practice may be included in an assignment including plotting of ellipses or other non-circular curves; graphs, etc.	F&S p.34,2.34 Z, p.68, 4.28 F, p.22, 2.17 F, p.42, 2.41 F, p.590, 22.31
1. irregular (French) curves-types; use of		
2. flexible curves - two main types - adjustable curve and spline.		
G. Protractors	Measure angles on a problem sheet.	F&S p.51,4.8 Z, p.67, 4.26 F, p.67, 4.27 F, p.590, 22.31
1. Materials used, shapes (semi-circular or circular); plain or vernier.		
2. Used to lay out angle.	Layout angles	
3. Used to measure angle.		
H. Paper types and uses		
1. Drawing papers, HP, CP and R and their uses for pencil and water color work.	Examine and draw on various types and grades of papers. In compliance with industrial practice however, most assignments throughout the year should be completed on tracing paper.	
2. "Natural" tracing papers of various grades.		

Basic Information	Operations and Projects	References
3. "Prepared" tracing papers of various grades.		
J. Drawing Boards and Covers		
1. Drawing Boards - materials in order of preference; construction; true edge; care of.	1. Examine the boards available to the students. Point out good and bad features and have them check out their boards for trueness of edge, etc.	Z, p.57, 4.5 F, p.18, 2.3
2. Drawing Board Covers - plasticized paper; drawing paper; Linoleum; plastic laminate. Point out advantages and disadvantages of each.	2. Demonstrate as many types as possible. It would be advantageous if each of the several covers is provided on several boards which can be used by the students.	
K. Erasing Devices		
1. Hand erasers - point out damage caused by hard, gritty erasers. Pink eraser for erasing of line work.	Early practice in the correct use of the various erasers and aids is desirable, before an advanced drawing is torn or spoiled due to lack of proper instruction.	F&S, p.145, 119 Z, p.69, 4.29
2. Erasing shields - advantage of metal over plastic; correct use.		F, p.20, 2.11 p.43, 2.42 p.363, 13.14
3. Electric Erasing machines - care in the use of.		

UNIT THREE - GEOMETRICAL CONSTRUCTIONS

Basic Information	Operations and Projects	References
A. Draftsman's methods applied to geometry.	Review through problems the basic constructions previously studied in Drafting 12.	F&S pp. 378-380
B. The function of geometrical constructions in solving drafting problems. The mathematical reasoning in relation to problems e.g. tangents in relation to arcs and ellipses, the ellipse as a conic section, loci, terms and definitions.		F&S pp. 49-59 G. pp. 90-121

Basic Information	Operations and Projects	References
The importance of these constructions in developing skill and precision in the use of instruments and sharp pencils. The application in a technical sense of these constructions.		
C. Geometrical constructions:	Drawing assignments involving the new constructions listed.	F&S pp. 55-59 G. p. 125-6
1. Arc tangent to two arcs.		
2. Ogee curve	Drawing assignments and/or job sheets applying these constructions to problems - e.g. geometrical figures, arches, "instrument panels", and "gaskets".	F&S p. 380 G. p. 125-6
3. To rectify an arc.		
4. Ellipse - trammel and concentric circle method.		
5. Helix		

UNIT IV - THEORY OF PROJECTION

A. Systems of Projection

This section deals with projection systems and their relation to each other. Individual systems of projection and their resulting drawings will be taken separately and in a detailed manner later in the course.

Basic Information	Operations and Projects	References
There are two classifications of projective systems:		
Perspective or central projection and Parallel projection.		G. p. 10 (see chart)
1. PERSPECTIVE		
A. The eye of the observer is at a finite distance from the object.		
B. Projectors converge to a station point.	This information should be made up in their notes complete with diagrams of a simple object such as a box, cube, etc., drawn in the three types of perspective.	F&S p. 198, 14.19; 14.20; 14.21.
C. Projectors pierce the picture plane at varying angles.		

Basic Information	Operations and Projects	References

D. Types of linear perspective.

1. One point (parallel)
2. Two point (angular)
3. Three point (oblique)

Students are not expected to make perspective drawings at this time.

The instructor should not attempt to teach the theory of perspective or the method of projecting a perspective but should sketch simple objects using one and two vanishing points. He could show samples of the various kinds of perspectives teaching recognition of these types.

2. PARALLEL PROJECTION

A. The eye of the observer is at an infinite distance from the object.

The information given by the instructor should be included in the student's notes complete with drawings of simple objects illustrating the kinds of parellel projection.

B. The projectors do not converge but are parellel.

C. The projectors pierce the picture plane at the same angle.

They should also make a sketch or chart of the projective systems similar to that shown in Giesecke, page 9, showing the relationship between systems.

D. Types of parallel projection:

1. Orthographic
   a. Multiview
   b. Axonometric
      (i) Isometric
      (ii) Dimetric
      (iii) Trimetric
2. Oblique
   a. Cabinet
   b. Cavalier

Note: Industrially accepted classification implies that orthographic means multiview and that the others are pictorial.

3. MULTIVIEW ORTHOGRAPHIC PROJECTION
Third Angle

A. Definition of orthographic projection (See F&S p.64, 5.6)

Study completely chapter five- memorize definition.

F&S p.64, 5.6

Basic Information	Operations and Projects	References
B. Planes of projection 1. Horizontal 2. Frontal 3. Profile		
C. Projectors are <u>perpendicular</u> to planes of projection		
D. "Glass box" principle	Notes complete with sketches	G. p. 159,207 F&S p.65, 5.7 & 5.8
E. C.S.A. (A.S.A.) arrangement of views		F. p.95, 5.4; 5.5
F. Alternate positions		G. p. 160,208 F&S p.66 Fig. 5-12 F. p.96 Fig. 5.10 G. p. 162 Fig. 289 Z. p. 26 Fig. 2-11 F. p. 97. 5.7
G. Principle of third angle projection - 4 quadrants.		Z. p. 27, 2.14
H. Representation of lines 1. edge view 2. intersection 3. surface limit		Z. p.25, 2-9 & fig 2-8 F. p. 101, 5-11
I. Classification of lines and surfaces. 1. Normal surfaces 2. Normal edges 3. Inclined surfaces Inclined edges 4. Oblique surfaces Oblique edges 5. Parallel edges 6. Curved surfaces 7. Cylindrical surfaces 8. Deformities of cylinders	Notes and drawings of very simple objects to illustrate these surfaces and edges as shown on the drawing.	G. p. 173, 224 to p. 180, 234

Basic Information	Operations and Projects	References
J. Line characteristics 1. Construction lines (with hard pencil) 2. Centre lines 3. Object lines 4. Hidden lines	The student could draw samples of these lines or they could be incorporated into a drawing of a simple object. They should master the techniques of drawing good lines before proceeding to more difficult drawings.	F. p.41,2.39 and 2.40 G.p. 20;21 Z. p.44,3-6 0 3-8
K. Precedence of lines	Notes.	F. p.102,5.14
L. The three space dimensions 1. Height 2. Width 3. Depth		Z. p.46,3-9 F&S p.62&63 fig 5-4 & 5-5 F. p. 98, 5.8
M. Selection of views	Notes and exercises	F&S p.71; 5-13 F&S p.94; 7.14
N. Spacing of views (paper sizes based on commercial letterhead size of $8\frac{1}{2}$ x 11)	Notes and a simple drawing using one method of spacing.	F. p.106;5.20 G. p.163;210 p.166,213
O. Projecting the views 1. Use of projectors 2. Transferring measurements a. with dividers b. by use of mitre line c. swinging arcs with compass d. with scale 3. Projecting an elliptical boundary	Study chapter seven completely. Problems for drawing - Pg. 387 D-37; D-38; D-39, D-40, D-41, D-50, D-94, etc. from French and Svenson or similar problems from Giesecke - French or Zozzora.	F. p.107; 5.21 to p.109; 5.25 G. p.163,166 to p. 210,213 Z. p.27,2-13 fig 2-12; 2-13a; 2-13b
4. Projecting a curved boundary.	Fundamentals i.e. layout, accuracy, neatness, correct line weights, lettering, etc. must be stressed at all times. It is felt that a large number of simple drawings, gradually becoming more difficult is more useful than a few laborious drawings. The above to be followed by a minimum of three drawings of actual objects.	F. p.110,5.26
P. Order of drawing		
2. MULTIVIEW DRAWINGS (first angle)		
A. Theory behind first angle	Notes, etc.	G. p.188, 243 Z. p.25,2-9,
B. Quadrants used	It is desired that students have a knowledge of this method only.	Fig. 2-8
C. Where this kind of projection is used.		

Basic Information	Operations and Projects	References
3. AUXILIARY VIEW (primary)		
A. Definition of primary auxiliary view.		
B. The auxiliary plane	Study all of chapter 9 (F&S)	Z p.167, 9-1 G. p.234;263
C. Folding lines		G. p.234;264 G. p.235,265
D. Reference planes		
E. Director of view and projectors		
F. Transferring measurements		F&S p.112, 9.6 G. p.236,266
G. How to draw a primary auxiliary view: 1. Using a folding line 2. Using a reference plane	The theoretical portion of this subject should be covered	
H. Plotting curves, circles, etc.	in the student's notes complete with diagrams, etc. Suggested	G. p. 243, 277
I. Completing principal views from auxiliary views	drawings.	
J. Hidden lines in auxiliary views	F&S PROBLEMS F 1, F 2, F 4, F 8, F 9, F 10.	F&S p. 114, 9.7 to p. 118, 9.16
K. Revolution of a line	Fundamental techniques and methods must be stressed and	
L. Steps to follow in drawing a primary auxiliary view	checked at all times.	
4. SECTIONS		
A. Definition	Study complete chapter	F&S, p.98,8.2
B. Cutting plane and line		F. p.216,8.3 to 8.8
C. Full section		G. p. 213, 250-53,255
D. Half section	Sectional drawing problems-	Z.p. 141,8-1
E. Section lining technique thin materials-outline sectioning, etc.	F&S - E.2, E.6, E.17, E.12, U12, U13, U14, U15, U17. Check techniques and methods closely.	F&S p.100,8.8 G. p.209, fig 405 Z.p. 143;8-6
F. Building Construction details		F. p.220; 8.11 G. p.208;247 Z. p.144,8-9

Basic Information	Operations and Projects	References
5. AXONOMETRIC (Gr. Axon - Axis) (metric-measure)		
Types of axonometric projection:		
-isometric		G. p. 481-482
-dimetric		
-trimetric		F&S 187
1. Isometric Drawing	Free hand sketching	Z. 193 GP 453-485
a. Positions of the isometric axes	Use a simple drawing to obtain practice and stress importance of proper layout of drawing.	Fig. 829 MP 47
b. Hidden lines in isometric drawings		G. p. 485-486 F&S 187-188
c. Center lines		
d. Box construction	The students should do several drawings which include all of the above principles.	G. p. 486
e. Dimensioning		
f. Non-isometric lines		G. p. 487
g. Irregular objects		F&S 189
h. Circles in isometric		G. p. 487
i. Isometric sectioning	Several simple drawings.	G. p. 488
		G. p. 488
	One drawing.	F&S 190
		G. p. 492
6. OBLIQUE		G. p. 494
		G.p. 496
1. Introduction		
a. Define oblique projection		Z-204
b. Direction of oblique projectors		F&S 195
c. Choice of position		G. p. 514, 515 516
2. Cabinet Drawing		
a. Define cabinet drawing	Several simple drawings that will show advantages to cabinet drawing applied to joinery cabinet and furniture construction.	F&S 195
i. angle of projectors		
ii. Length of receding lines		G. p. 516
		G. p. 517-518 Fig. 883
3. Cavalier Drawing		
a. Define cavalier drawing	Simple cavalier drawings of machine parts.	
b. Use of cavalier, limitation		
i. Angle of receding lines		
ii. Length of receding lines		

Basic Information	Operations and Projects	References
A. Introduction to Dimensioning	This unit should be introduced early in the course and applied to all drawing problems in the other units.	F&S p. 124
B. Systems of Dimensioning		
1. Aligned system		
2. Unidirectional system		
3. Where used.		
C. Placement of Dimensions		
1. Off views where possible	Study chapter X in text to the end of 10.15	G. p. 298-309
2. Between views		F. p. 286-288
3. Close to part affected		
4. On contour view		
5. Specified distance from views and from other dimensions		
D. Dimensioning of:		
1. Prisms		G. p. 311
2. Cylinder		G. p. 311
3. Hexagons, octagons, etc.		
4. Pyramids		
5. Circles		
6. Chamfers		
E. Geometric Breakdown		G. p. 309
1. Size dimensions		F. p. 282
2. Location dimensions		
F. Notes		
1. Types and uses		
2. Placement of notes		
G. Dimensioning Practices on Pictorial Drawings		

Basic Information	Operations and Projects	References
A. Introduction		
1. General purpose of reproducing		
B. Materials		F&S p. 150-151
1. Sensitized papers		
2. Masters		
3. Prints		
C. Blueprints	Examples only and general procedure used.	
D. White Prints	Examples and experience in producing prints and tracing.	

THEORY
(To be taught in Drafting room)

The following units on Metalworking Related Theory, are to be taught in the drafting room by the drafting instructor. Wherever applicable, this material should be related to the mechanical drafting in the previous units. It is imperative that the drafting and the machine shop instructors work in close harmony with each other in order that their students may obtain the greatest value from this theory, and the practical experiences in Part II Metalworking.

UNIT VII - LAYOUT WORK

Basic Information	Operations and Projects	References
A. Measuring Tools		
1. Fractional systems of measurement. 2. Steel rules: plain, hookend, depth gauge. 3. Calipers: outside, inside, hermaphrodite. 4. Micrometer caliper i. Parts and construction ii. Theory behind iii. How to use 5. Vernier calipers i. Parts and construction ii. Theory behind	Students could sketch, measure and dimension objects such as machine parts, using the measuring tools listed. Students should "mike" thicknesses of stock, machined diameters, etc.	Krar Chapter 4 Jam Handy Filmstrips Measurements and measuring parts 1 and 2. Layout work part 1 & 2. Layout tools and measuring instruments.
B. Layout Tools	Taught in shop	

UNIT VIII - BENCH WORK

Basic Information	Operations and Projects	References
A. Files and filing parts, shapes and cuts. Finishes and accuracy that can be expected.	Sample of each shown to class. Notes on files could be included.	Krar p. 38 to 40. File Filosophy - Nicholson File Co.

Basic Information	Operations and Projects	References
B. Hacksaw	Lesson and notes on blade types and where used. Selection of proper tooth size.	Krar p. 36, 37
C. Drill Bits - Cutting principles, drill angles, parts of twist drills. Limits of accuracy.	Notes on parts of drills, cutting angles and relief angles. How to represent drilled holes in sectional drawings and in hidden detail. Angle used for drawing (120° instead of 118° etc.)	Krar p. 60-62
D. Hand Threading - Threads, thread profiles, parts of threads, specifying threads, plotting a helix, thread representation, calculating tapping drill size.	Sketching and drawing of threads Problems calculating tapping drill size. Exercises in calling up threads on drawings. Use of tables in drafting books.	F&S p. 152-160
E. Taps - taper, plug and bottoming, size, identification.	Sequence of steps in tapping. Lubricants.	Krar p. 42-43
F. Dies - size identification	Sequence of steps.	Krar p. 44
G. Hand Reaming	Purpose, accuracy, amount of metal that can be removed calling up on a drawing.	

UNIT IX - METAL FASTENERS

Basic Information	Operations and Projects	References
A. Threaded Fasteners 1. Bolts and nuts 2. Cap screws 3. Machine screws 4. Studs Definitions of each and where used. Coarse and fine thread series.	Examples, notes, sketches and drawings using some of the more common fasteners. Use of tables in determining proportions, depth of tapped holes, etc. Students should be able to recognize and specify each of these fasteners. Wrench clearance required. Recognition of head shapes and correct method of specifying rivets on drawings.	Krar p. 44 F&S Chap. 12
B. Rivets - Head shapes, where used, advantages and disadvantages of riveting. Types of riveted joints.	Determining length of rivet required. Clearance, holes, hot and cold riveting.	G. p. 698

Basic Information	Operations and Projects	References
C. Pins 1. Dowel 2. Taper Definitions; where used; advantages and disadvantages.		G.P. 385

UNIT X - THE DRILL PRESS

Basic Information	Operations and Projects	References
A. Parts, drill holding devices, types of twist drill shanks, speeds and feeds, lubrication and cutting fluids, work holding devices, spot-facing, counterboring, countersinking, etc., where used.	Lessons - Notes and tests, etc., on the subjects listed on the left; where and why these are used. Method of calling processes up on a drawing. Problems calculating cutting speed, r.p.m. etc.	Krar, Chap. 12

UNIT XI - THE ENGINE LATHE

Basic Information	Operations and Projects	References
History, importance, parts and construction, safety. Operating speeds, carriage controls and feeds. Turning tools. Chucks - chucking work, centering, facing centre holes, etc. Turning between centres, etc. Recessing chamfering, etc. Taper turning, threading. Drilling, boring and reaming on a lathe.	Students should be required to make notes and answer tests, etc.	Krar, Chap. 10 Jam Handy Filmstrip on Engine Lathe Film # 1 " # 2 " # 3 " # 4 " # 5 " # 6 " # 7 " # 8 " # 9 " #10 How to run a lathe - South Bend Lathe Co.

UNIT XII - ABRASIVES AND GRINDING

Basic Information	Operations and Projects	References
A. Abrasives		Krar, Chap. 13
1. Free Particles i. Kinds ii. Grain size		
2. Stones (rotary) i. Composition and method of manufacture ii. Shapes - some common shapes and where used iii. Paper and cloths - Grading and grit size, where used.		
3. Ground Surfaces i. Kinds of surface finish and accuracy that can be expected from grinding. ii. Surface finish symbols	Introduction only is intended. Depth of coverage to be determined by the instructor.	

UNIT XIII - METALLURGY

Basic Information	Operations and Projects	References
A. Properties of Metals		Krar, Chap. 6
1. Hardness 2. Brittleness 3. Malleability 4. Ductility 5. Elasticity 6. Fusibility 7. Tensile strength		Ftier
B. Manufacture of Iron and Steel		
1. Pig Iron - blast furnace construction and principles of operation. Properties of pig iron		

Basic Information	Operations and Projects	References

2. Cast Iron - How produced. Cupola furnace, gray and white cast; where each used. Sand casting process, parts of flask, cores etc. Permanent mold casting. — G. p. 271

3. Steel - Conversion of iron to steel.

   a. Bessemer Process. When invented - advantages and disadvantages.
   b. Open hearth process. Construction and operation, why used. Purity to be expected. Size, capacity, etc. Controlling carbon content and impurities. — Frier
   c. Electric furnace process - where and why used.
   d. Carbon Steel - importance of carbon in steel. Low, medium and high carbon steels, where each used.
   e. Alloy Steels - function of alloying metals used for alloying. S.A.E. system of classifying alloys. Importance of calling up alloy specs. on drawings.
   f. Heat Treatment
      i. Annealing
      ii. Hardening
      iii. Tempering
      iv. Hardness testing

A simple treatment of heat treating is all that is required. The general principle of Brinell and Rockwell hardness testing could be explained.

Basic Information	Operations and Projects	References
C. Copper - refining of copper; characteristics; where used; strength.		
D. Bronze - Alloy of copper and tin; characteristics; where used; strength.		
E. Brass - Alloy of copper and zinc; characteristics; where used; strength.		
F. Aluminum - characteristics; where used; how strength can be increased by alloying.		Alcan - Handbook of Aluminum

W. T. Frier - "Elementary Metallurgy", 1952, McGraw-Hill Book Co.

Part Two - Metalworking

Text: S. J. Krar, J. E. St. Amand, Machine Shop Training, McGraw-Hill Book Co. Ltd.

This portion of the Drafting 22 program is intended to give the student some practical experience in the field of metalworking.

For efficient presentation of this unit, there should be close liaison between the machine shop and the drafting instructors. It is intended that the theory, Units VII to XIII, Part I, will be taught in the drafting room by the drafting teacher, leaving the shop instructor free to concentrate on shop instruction and practice. This arrangement should insure that the metalworking portion will be presented in a manner that will emphasize those shop procedures important to the draftsman.

Note: In the study and use of machines, emphasis in this subject should be on use and capabilities of the machines. No attention should be devoted to such facets as construction, names of parts, maintenance and so forth, excepting those items which are directly useful and necessary to the operation of the machine.

UNIT I - MEASURING AND LAYOUT

Tools and Processes	Shop Work	Theory
A. Layout Work		
1. Measuring Tools		
a. Care of tools		
b. Fractional systems		
c. Steel rules: plain, hookend, depth gauge.		
d. Calipers: outside, inside, hermaphrodite		Discuss how the draftsman uses each of these tools to measure existing objects in order to make sketches and drawings of them. Construction and theory and use of micrometers is particularly important.
e. Micrometer calipers: outside and inside.		
f. Vernier calipers	Demonstrate how each of these tools is used. Have students use most of them in the layout of simple projects.	
2. Layout Tools		
a. Surface preparation: layout fluid, copper sulfate solution, etc.		
b. Surface plates and layout benches.		
c. Scriber		
d. Prick punch		
e. Centre punch		
f. Squares: Try, combination set.		
g. Dividers		
h. Templates		

Tools and Processes	Shop Work	Theory
A. Bench Work		
1. Machinists vise: Use of soft jaws. 2. Hammers: ball peen, soft faced. 3. Chisels: flat, cape, round nose and diamond point. 4. Files and filing: parts, shapes, cuts and uses of various files. 5. Hacksaw: blade types and uses, selection of proper tooth size. 6. Drills: electric and hand. 7. Drill bits: types and use, sharpening twist drills. 8. Taps: plug, taper and bottoming, size identification, use, cutting oils. 9. Dies: size identification, use, cutting oils. 10. Hand Reaming: purpose, method of use, lubrication, care. 11. Metal Fasteners: Machine screws, bolts, cap screws and studs, dowel and taper pins, rivets and riveting, wrenches and their use.	Bench operations to be performed: cutting, shaping and finishing of mild steel, hand sawing of thick materials, and tubing, drilling and tapping of mating and positioned holes; counterboring, countersinking and spotfacing holes; threading a rod and fitting it to a tapped hole; drilling and reaming to fit an existing shaft; riveting round and flat head rivets in thick and thin materials. Correct use of open end, box end and socket wrenches. Filing - flat work, testing for flatness, prevention of pinning, draw filing. Fastening parts together using various forms of fasteners.	Parts, shapes, and cuts. Finishes and accuracy that can be expected from filing. Cutting principles, drill and angles. Drawing of drilled holes in hidden detail and sections. Limits of accuracy that can be expected. Thread shapes, parts of threads, specifying threads, calculating tapping drill sizes, plotting a helix, drawing sharp vee threads, thread representation. Purpose for reaming, accuracy that can be counted on. Amount of metal that can be removed. Definitions of each type, where used, use of tables to determine proportions, etc. depth of tapped holes. Where to use coarse and fine thread series, specifying these on a drawing. Purpose of riveting. Types of head shapes, clearance holes, hot and cold riveting. Where used. Length. Use of tables to determine wrench clearance.

UNIT III - ABRASIVES AND GRINDING

Tools and Processes	Shop Work	Theory
A. Abrasives		
1. Free particles 2. Stones 3. Paper and cloths	Polishing	Definition of abrasives surface finish, accuracy, etc.
B. Grinding Machines		
1. Bench and pedestal grinders 2. Surface grinders 3. Cut off wheel 4. Centerless grinder 5. Portable grinders	Safe operation and use of available types. Holding work, selection and dressing of wheels. Mounting wheels.	
C. Tool Grinding (Offhand)	Recognition and tests for tool materials. Grinding lathe tools, twist drills, etc.	

UNIT IV - DRILLING

Tools and Processes	Shop Work	Theory
A. The Drill Press		
Parts and construction. Operation and care. Tool holding devices. Twist drills: parts and types of shanks, systems of sizing. Speeds and feeds cutting fluids. Drilling spotfacing counter boring. Counter sinking, reaming.	Projects incorporating the processes at the left. These should be simple but interesting. These projects or exercises should be made from working drawings.	Parts of D.P. (drawing). Where drilling, spotfacing, countersinking are used. How to specify them on drawings. Notes on tool holding devices. Accuracy of drilled holes. Calculating cutting speeds, r.p.m., etc.

UNIT V - THE ENGINE LATHE

Tools and Processes	Shop Work	Theory
A. Parts and Construction	Demonstration in Shop	Printed sheets showing lathe components.
1. Work holding devices, chucks, face plates, drive plates, dogs, etc.	Shop demonstration and student use.	Jam Handy Filmstrips.
2. Facing - Turning between centres. Rough cut, finish cut, turning to accurate size. (plus or minus .003), Knurling. Turning to a shoulder, necking (thread relief)	Students should turn exercises or projects that include the processes on left.	
3. Taper Turning a. Offset tailstock b. Taper attachment c. Compound rest Drilling, boring and reaming on a lathe.		
4. Threading a. tapping b. cutting ext. threads with a die c. cutting external V. threads with a lathe tool.	For more advanced students.	

UNIT VI - METALLURGY

Tools and Processes	Shop Work	Theory
A. Properties of Metals		Hardness Brittleness Malleability Ductility Elasticity Fusibility Tensile strength

Tools and Processes	Shop Work	Theory
B. Manufacture of Iron & Steel		Blast Furnace - Consturction and principles of operation (simple chemical reactions) Cupola Furnace - Grey cast iron and white cast iron. Difference; where each used.
1. Pig iron 2. Cast iron		
3. Casting processes	Trip to industry Films.	Sand casting.
4. Steel		Cores. Permanent mold casting.
a. Mild steel b. Carbon steel c. Alloy steel	Spark test for high carbon steel	Bessemer Converter. When invented - advantages and disadvantages.
		Open hearth furnace. Construction and operation. Why used. Purity to be expected. General size, capacity etc. Controlling carbon and impurities. Electric furnace. Annealing, hardening and tempering steel. Desirability of alloys. Metals used for alloying. S.A.E. system of numbering. Importance of calling up alloy spec. nos. on drawings.
C. Copper		Refining; characteristics, where used, strength.
D. Bronze		Alloy of copper and tin. Characteristics, where used, strength.
E. Brass		Alloy of copper and zinc. Characteristics, where used, strength.
F. Aluminum Properties of Metals		Characteristics - How alloys can change.

DRAFTING 32

Drafting 32 consists of:

Part One - Drafting (10 or 15 credits)
Part Two - Building Construction (5 credits)

PART ONE

UNIT I - TRADE INFORMATION
(Suggested time - 10 hours)

Basic Information	Operations and Projects
1. The place of the draftsman in industry.	Reports, discussions, field trips, and speakers from industry
2. Comparison of incomes	
3. Opportunities for advancement	
4. Related occupations	
5. Stability of the job	
6. Hours of work	
7. Employment outlook	
8. Health hazards	
9. Training and costs	
10. Opportunities for employment	
11. New developments and trends in drafting	

The following is a list of additional references recommended for this unit:

Graphic Science - David Z. Orlow Publishers, Reader Service Department, Graphic Science, Two John Street, New York.
(Subscription $9.00 per year - Complimentary copy possible)

Occupational Trends and Employment Opportunities - Guidance Branch, Department of Education, Edmonton.

Summary of Employment Conditions - National Employment Service, Prairie Region, Winnipeg.

Industry - Published by the Manufacture Association, 67 Yonge Street, Toronto

Career Guide for Demand Occupations - Guidance Branch, Department of Education

Industrial Design as a Career - The Society of Industrial Designers, New York 17, N.Y. (Prints for Drafting

Occupational Bulletin - Department of Veteran Affairs, Draughtsman issue.

Canadian Occupations Careers in Drafting, Department of Labour, Ottawa.

High News - 1964 Career Supplement and Canadian Business Guide, Brompton, Ontario. #18, Vol. XXIV (Issue for the year)

UNIT II - BLUEPRINT READING (GRAPHIC INTERPRETATION)

(Suggested time - 15 hours)

Introduction and Definition

Blueprint reading, or (more recently) graphic interpretation, refers to the understanding of ideas and instructions which are expressed on drawings.

In all manufacturing and service trades, drawings and sketches are used to present a clear, concise, and complete set of instructions. It is through these that the engineer or designer communicates with the skilled tradesman.

The proper use and interpretation of standardized methods is an integral part of this graphic language. This language involves an understanding of lines, sections, symbols, dimensions, conventions, notations and titles.

Objectives

To teach the student to interpret practical drawings into working ideas.

To develop the students skill in reading working drawings with speed and accuracy.

To stimulate interest in and increase the students' technical knowledge of specific trades.

Recommended Workbook

Blueprint Reading - Checking - Testing by Otto Steinike
1956 - McKnight and McKnight Publishers (2nd Edition)

Parts I Instruction, and Part II Blueprints

Basic Information	Operations and Projects	References
	Present several simple to more complex dimensioned orthographic drawings for interpretation.	T. A. Diamond or any other introductory text.
	Present several dimensioned pictorial drawings (isometric or oblique) for interpretation.	T. A. Diamond or any other introductory text.
	Present several unfamiliar dimensioned orthographic drawings and have the student transfer dimensions.	Select at random from available texts.
	Present several unfamiliar dimensioned isometric or oblique drawings and have the student transfer dimensions to an orthographic.	Steinike. 39 projects to select from.
	Present various detailed drawings to check orally the students' ability to identify lines, surfaces, symbols and sections.	Steinike select at random.
	Present working drawings from any or all of the following: mechanical, sheet metal, structural steel, reinforced concrete, architectural, piping, electrical, welding, etc.	Blueprint Reading Texts from the various trades or obtain actual prints for industry to use as reference.

ADDITIONAL REFERENCE BOOKS - BLUEPRINT READING (GENERAL & SPECIFIC)

1. A Primer of Blueprint Reading, T. A. Diamond - Bruce Publishers.
2. Industrial Arts Blueprint Reading, S. L. Coover - McGraw-Hill.
3. Basic Blueprint Reading & Sketching, Olive & Payne - Delmar Publishers.
4. Blueprint Reading & Sketching, U. S. Navy Courses - U. S. Govt. Printing Office.
5. Blueprint Reading, Nicholson & Jones - D. Van Nostrand.
6. Programmed Blueprint Reading, Coover & Helsel - McGraw-Hill
7. Blueprint Reading for the Metal Trades, DeVette - Bruce Publishers
8. Blueprint Reading for the Welders, Bennett, Delmar.

9. Automotive Drawing Interpretation, L. S. Jensen - L. S. Jensen - Delmar.

10. Blueprint Reading for the Plumbing Trades, D'Archangelo - Delmar.

11. How to Read Electrical Blueprints, Heine - McGraw-Hill.

12. Blueprint Reading & Sketching for Electrical Trades, Residential - Delmar.

13. Blueprint Reading & Sketching for Electrical Trades, Commercial - Delmar.

14. Blueprint Reading for the Building Trades, Part I, American Tech.

15. Blueprint Reading for the Building Trades, Part II, American Tech.

16. Blueprint Reading for the Building Trades, J. E. Kenny, McGraw-Hill.

17. Advanced Blueprint Reading Vol. I - Delmar.

18. Advanced Blueprint Reading Vol. II - Delmar.

Note: Most of these texts are available with a teacher's guide to solutions.

UNIT III - DESIGN FUNDAMENTALS
(SUGGESTED TIME - 50 HOURS)

I. OBJECTIVES

A. To learn the techniques and develop the skill in the freehand use of the pencil for illustration purposes.

B. To develop, by very simple steps, a basic understanding of the fundamental principles and elements of visual design.

C. To develop and exercise the imaginative abilities of the student.

D. To provide a basis for student and teacher to measure and evaluate the student's ability and interest in creative visual design.

II. REFERENCES

Instruction in this unit may be guided principally by the following references:

1. "Pencil Drawing" Part I by Arthur L. Guptill, Reinhold (Code reference will be "C")

2. "Design Fundamentals" by C. J. Feldsted, Isaac Pitman and Sons (Code Reference will be "F")

3. "Design and Form" by Johannes Itten, Reinhold (Code reference will be "Itt")

Extensive use should be made of organized and well illustrated student notes.

III. EQUIPMENT

A. Graphite pencils - 3B - 4B - 5B - 6B.

B. Charcoal pencils - H, 2B, 4B, 6B.

C. Carbon pencil - BB.

D. Reeves sketch book 11" x 14".

E. Strathmore Alexis paper.

F. Onion skin paper 17" x 22".

G. 10 lb. bond paper 17" x 22".

H. Kneaded Eraser.

I. Art Gum Eraser.

J. Pink Pearl Eraser.

K. Sketchboard - 3/16" x 12" x 14" tempered masonite.

L. Can of fixatif (One for class is sufficient).

IV. HOMEWORK

Homework in this unit shall consist of practice assignments in the use of techniques demonstrated in class. A considerable amount of the daily practice necessary to develop the skills of this means of expression shall be obtained in this manner. Students should be encouraged to engage in short, but intensive daily projects during which they quickly sketch a variety of exercise, subjects, and design. Duration of these sketch periods should be from 15 to 30 minutes. Results of each week's work should be displayed, examined, criticized and discussed by the instructor and the class at the succeeding class period. This practice work shall culminate in production by the student of work for inclusion in his portfolio. All such work should be rated.

V. DIVISIONS OF THE UNIT

A. Freehand Sketching
   1. Purposes and Objectives
   2. Materials for Sketching
   3. Preparations for Sketching
   4. Stroking Techniques and Practice
   5. Tone Building Techniques and Practice
   6. Light, Shade and Shadow
   7. Texture Representation
   8. Making Transfers
   9. Constructing the Subject
   10. Rendering the Subject

B. Fundamentals of Design
   1. Introduction and Definitions and meanings of design, art, architecture, industrial design.
   2. Importance of design to the draftsman.
   3. Industrial and architectural designs.
   4. Principles of design.
   5. Units of expression.
   6. Design problems - line and point.
   7. Design problems - area and value.
   8. Design problems - texture.

VI. METHOD OF PRESENTATION

This unit of the course embraces two principal topics of study - sketching and design. The former is a tool for the expression of the latter. It is suggested that the two branches be studied in a parallel program with the entire design section being completed at the same time as division 8 of the sketching program is completed. The principles of design developed to this point would then be employed in the development of divisions 9 and 10 of the sketching outline. Media of expression for this unit should be the lead pencil only. Graphite, carbon and charcoal pencils all may be employed. An assorted variety of smooth and coarse textured papers also should be used.

This is a "learn by doing" course. Although some instruction, which is heavily supported by demonstration and illustration, is necessary, and well illustrated notes are required, instruction should be carried out largely by having the student sketch and design extensively.

At least two sketch portfolios shall be produced by each student. The one shall contain all of the final efforts in his sketching exercises, the other the final design assignments which he produces and submits. Students should also be encouraged to make organized portfolios of their practice work. It will be necessary for all students to preserve their notes, sketch portfolio and design portfolio to be carried forward to the next year of the course. These will be required during the "B" Year at the Technical Institute.

The student should be encouraged to extend all exercise through use of his own imagination. He should be required, however, to maintain a similar order of difficulty, and discouraged from tackling complex subjects.

Teachers are reminded that instruction of this unit will be by demonstration in the media which are being employed by the students. This implies both a knowledge of an a constantly maintained level of skill in both sketching and design.

Finally, it is suggested that this unit be developed in a manner designed to help the student to derive pleasure and enjoyment from the subject. The approach should be light and imaginative and must encourage play of interest and imagination and the rapid production, rather than laborious, production of designs and sketches.

Should the program degenerate into the plodding and laborious completion of a series of dull and detailed exercises, very little will likely be accomplished.

VII. DETAILED OUTLINE OF THE UNIT

A. Freehand Sketching

1. Purposes and Objectives

a. Purposes
- To develop the facility to converse freely by graphical means.
- To provide a tool for use in visualizing, conceiving and inventing physical things.
- To provide a means of expressing artistic design.
- To provide an efficient tool for gathering of technical data concerning shape description of physical things.
- To provide a means of interpreting technical drawing.

Purposes of freehand drawing as employed in the industrial world would be carefully developed for the student who has little understanding of and no experience with this segment of life. If he is to have a genuine interest and to enjoy a driving purpose in carrying out this unit of study, these purposes and objectives must be discussed, illustrated and finally defined and set down in notebooks for later consultation. Upon the efficiency of this introduction will largely depend the interest and success of the program.

b. Objectives
- The objective of this unit is to begin to develop the ability of the drafting student to use to the full, his principle tool - the pencil. Facility in linear drawing and illustration are both objectives.

2. Materials for Sketching

Materials for this unit of work are listed under Section III "Equipment".

a. Pencils: types-graphite, carbon, charcoal; hardness range; types of points; purposes and effect.

While some of the factual information relating to materials must be developed before work is begun, much of this information is better brought out as it is encountered during the work of the unit. In any case, notes containing factual information should be compiled by the student and kept for the future reference. These notes may be effectively augmented by such things as mounted samples of papers and illustrations of the results of various material combinations and so forth.

Basic Information	Operations and Projects	References

b. Papers: types - tracing, sketch papers, smooth, medium and rough 'textures', illustration board; purposes; effects; costs; mounting.

c. Erasers: types - hard, art gum, kneaded; purposes; methods of use.

d. Erasing shield: uses particularly adapted to sketching, trimming, high lighting, etc.

e. Sketch board: types; purposes; mounting devices; baffling.

f. Dusting brush; purpose and method of use.

g. Fixatifs: types; methods of application.

3. Preparations for Sketching

a. The work station: drawing tables; drawing boards; sketch boards.

b. Mounting and preparation of drawing paper: baffling, fastening, bordering, identifying, titling.

c. Laying out the drawing surface. (Exercise work).

Advantages, limitations and methods of using sloped and vertical drawing tables and drawing boards, the flexibility of the sketch board, should be discussed and demonstrated. Specific methods for finishing and identifying work and author should be set forth and invariably required.

Freehand methods of proportioning and laying out the drawing surface shall be demonstrated and followed by the students.

NOTE: It should be required from the outset that no ruled lines of any kind be permitted on any freehand sketching assignment.

Basic Information	Operations and Projects	References
4. Stroking Techniques and Practice Demonstrate and illustrate results of:		
a. Methods of sharpening and using pencil points.		G. 12
b. Methods of holding the pencil.		G. 10 11
c. Stroking methods: arm pivot, finger pivot, slow stroke, fast stroke, irregular stroke, curved strokes, scrumbled strokes.	Have students draw a considerable number of practice sheets until a satisfactory level of skill with all sheets is obtained. A minimum of four sheets at the best level of attainment should be submitted for marking and inclusion in the sketching portfolio. Exercises similar to those of figures 10 and 11 of Guptill are suggested. Suggested sheet sizes 11" x 14" or 11" x 15".	G. 13 14
5. Tone Building Techniques and Practice	Construct a clearly defined 10-step value scale in untextured shades of grey. Have students complete a number of practice sheets culminating in at least two sheets which are to be included in the sketching portfolio. The first of these could be similar to figure 13 of Guptill. The second sheet might consist of a two dimensional tonal rendering of some simple object. Or it might be a similarly composed sheet to the first but employing different tones, patterns, pencils and papers.	
a. The value scale: Definition, eye training, value.		
b. Tone building methods. Develop common pencil methods of building tones; line tone and true tone methods; flat and graded tones; decorative or pattern tones.		
c. Tone building influences: pencil type; pencil grade; (smooth, medium and coarse) papers.		
6. Light, Shade and Shadow	A minimum of two sheets should be completed under this topic. A sheet should be produced showing the common geometric solids with light, shade and shadow shown by at least two of line, true tone, or dot methods of shading. Sheet may be patterned from figure 19 of Guptill and extended. The second sheet may be of a subject similar	G. 23
a. Consideration of light source and direction.		
b. Types of light: indoor, outdoor, intense point sources, diffused; effects of these.		

Basic Information	Operations and Projects	References
c. Lighted areas and highlights d. Cast shadows e. Reflected light f. Typical light, shade and shadow of basic geometric solids.	to that of figure 18 of Guptill. All subjects should be simple at this stage. The usual practice work should precede work for submission.	
7. Texture Representation Discuss, illustrate and demonstrate: a. Characteristics represented by textural treatment: rough-smooth ; hard-soft; dull-shiny; transparent-opaque; much-little. b. Realistic textures: wood, cloth, stone, brick, grass, water, glass, trees, etc. c. Devices for representing texture: line, graded line, tone, tone-line combinations. d. Texturing with underlays. The device of employing a roughly textured material underlying a thin paper should be experimented with. Texture may be "lifted" by using the sides or blunt ends of any of the soft pencils on the thin paper. In this section, special effort must be made to bring into play a wide range of materials - pencils, papers, textural patterns and actual materials for both imitation and underlay.	A minimum of two sheets should be completed under this topic. The first sheet might be composed similarly to figure 13 of Guptill, but should show various textural conventional treatments, and should exemplify contrasts such as dull-shiny, rough-smooth, etc. Sheet two might show real textures such as stone, glass, water, brick, screen, as a sheet similar to figure 13 of Guptill, as a montage, or as simple subjects such as are shown in figures 20, 28, 36 (1 and 2), of Guptill. Some examples of natural textures should be produced by using underlays of materials such as rough paper, rough wood grain, screening, canvas etc. Extensive exercise of the student's imagination should be resorted to here.	G. 26, 27

Basic Information	Operations and Projects	References
8. Making Transfers Methods of making transfers using soft pencils, thin papers, and an embossing tool (smooth end of ball point pen, teaspoon or the like) should be demonstrated. Building of symmetrical and repeated transfers by folding and retransferring should also be demonstrated. Usefulness of this device in other areas of work should be pointed out. e.g. The method of transferring of patterns produced for the wood or art metal shop.	This device may be employed in making several frames of the textural problem sheets where an over-all pattern may be used. A separate sheet of transfers alone might be produced for inclusion in the portfolio of sketches.	G 37
9. Constructing the Subject a. By outline b. By tracing paper method c. By scrumbling technique (scribbles, spirals and such) d. By tracing on glass e. By tone method NOTE: The last two methods above are not common, and should be demonstrated only if time permits. The better or faster students might also be permitted.	At this point several simple still-lifes, landscapes, buildings should be drawn. The principles of design should be now brought into application in the posing, construction, and rendering of from four to eight culminating pencil renderings. These renderings will apply and put into practice the instruction of this and the succeeding section - number 10 "Rendering the Subject". Some exercise or practice work on the subject matter of both sections 9 and 10 should be done before attempting the renderings. At least three renderings, each by a different method, should be completed by each student. One rendering, at least, should be completed using a combination technique.	G 28, 29, 30, 31. G 32,33 G 35 G 34 G 38,39 G 40,41 G 42,43 G 44,45 G 46,47

Basic Information	Operations and Projects	References

10. Rendering the Subject

Demonstrate with a wide variety of media and set forth in notes the following methods of pencil rendering:

a. Outline method. (Stress and demonstrate that this method is a convention and does not appear in nature).

b. Mass shading method

c. Broad line technique

d. Fine line technique

e. By combined techniques

B. Fundamentals of Design

1. Introduction and Definition of Terms

The importance of proper motivation and arousing of interest in the student in regard to this subject cannot be over-stressed. In many areas of the technical work in which he may be later engaged, he will be intimately associated with the design process. As a technician his function will be to carry out the practical planning for manufacture of construction of designs created by his professional counterpart, the industrial designer or architect. In many instances in later years of his employment, he may be directly engaged with problems of creative design himself.

He should be encouraged to continue throughout his life his interest and a process of self education in the subject of practical aesthetic design.

An understanding of, and practical ability to carry out the design process is therefore essential to his success.

Definitions:

a. Design: The activity of planning and producing sketches and drawings for the creation of some physical thing which has the three necessary characteristics of function, aesthetic appeal and physical soundness.

At this point inspiration, motivation and understanding of design in industrial life are the primary objectives. The teacher must call upon all available resources in industrial design, architectural design and art magazines, upon

Basic Information	Operations and Projects	References

visual aids, and upon any other available resources including field trips to acquaint the student with the function and importance of design in the industrial picture. The concept that industry is design must be developed.

b. Art: The principles of creative work generally and having to do with form and beauty in architecture and articles for manufacture.

c. Architecture: Having to do with the science, art, profession and business of designing and constructing buildings.

d. Industrial Design: Activities having to do with the design and manufacture of articles which have beauty and aesthetic appeal, are functional, sound in construction and economical to manufacture.

While it is essential that a strong beginning be made in this respect in order to provide initial stimulus and interest, no opportunity to further this education throughout the course should be lost.

2. Importance of Design to the Draftsman

Draftsman's function in the design process must be developed. As immediate associate of his principal - the industrial designer, engineer, or architect - it is his task to take the design sketches which portray the initial design concept and produce drawings which set forth the detailed functional concept of the design in actual materials, of specific size, and with efficient means of connection. While carrying out this part of the process he must be aware of and understand the intent of the initial design and be able to develop the functional design in harmony with the original concept. The draftsman also finds that, as his experience grows, much of the design of detail in its entirety is his responsibility.

This section of the work must also be developed by calling upon visual material drawn from design publications, and, probably most important, upon typical design and working drawings which have been produced for industrial and architectural products and structures, and which exemplify the ideas suggested here. This is a difficult section for which to secure source material. The success with which it is developed will depend very largely upon the initiative and resourcefulness of the teacher.

Basic Information	Operations and Projects	References

3. Industrial and Architectural Designs

A wide variety of designs of industrial goods and architecture should be reviewed with attention to how functional and in particular aesthetic design success was achieved. A particularly effective device is to select examples of good and of poor design of similar subjects, and contrast the result. The objective is to bring home to the student the part that the exercise of good aesthetic design plays upon the subject designed and to demonstrate that it is an active and practical consideration throughout industry.

Illustrations from trade, professional and design magazines, typical sets of working drawings, manufactured articles and existing buildings should be studied and examined and some initial effort made to discover whether and by what means aesthetic and functional qualifies have been attained.

Extensive use of slides and films from art, architectural and industrial design collections are extremely useful when available.

Files and scrapbooks of suitable material should be accumulated by the instructor and by the students to further this study.

4. Principles of Design

The following principles of design shall be developed as they relate to aesthetic design. Design is order produced by:

Notes with many accompanying illustrations should be made by the student to illustrate:

a. Harmony - This is the quality of agreement, or oneness produced in the design by similarity of line, shape, size, texture, color.

a. Harmony of direction, size, shape, texture, mass, color. F1 to F4

b. Balance - This is a state of equilibrium created by equal opposition or equal attraction. This is attained by balancing masses, sizes, materials, textures, colors, directions in symmetrical or asymmetrical arrangements.

b. Balance produced by equal mass, in symmetry, unequal masses in asymmetrical balance, balance by value, balancing of small areas of intense color with large areas of neutral color, of small areas of strong texture by large untextured areas, balance by contrasting directions, balance of lines and so on. F4 to F6

Basic Information	Operations and Projects	References
c. Rhythm - This is "movement" created in the design by instability introduced in the design which causes the eye to move over the design. It is produced by repetition in equal, diminishing or increasing measure. This instability can be produced by manipulation of mass, area, tone, color, texture and so forth.	c. Rhythm-movement created by instability; by regular, or decreasing measures; by rhythmical repetitions of values, textures, color, line, area, shape, or arrangement.	F6 to F9
d. Contrasts - These are tensions in the design created by contrasts in design elements such as large-small, light-heavy, rough-smooth, hard-soft, dull-shiny, transparent-opaque, etc. They enhance the magnetic interest of the design and are produced by the play of natural and conventional textures, tones, lines, colors and patterns.	d. Tensions created in simple designs by contrasts of large-small masses, hard-soft surfaces, coarse-smooth textured, bright-neutral colors, shiny-dull surfaces, intense-low value and so forth. In addition to reproducing the examples given by the teacher in his notes, each student should be required to expand each idea by contributing one or more of his own. While much of his design examples must be created by pencil techniques, some work should be done with actual materials in montages and so forth.	
5. Units of Expression The "bricks" or units with which we build or create a design are: a. The Line - which may be straight or curved, flowing or angular, which may radiate or converge, be bold, delicate or soft. It may be part of or independent from the form of the design. Or it may be outline, contour, and so forth.	The student again should be required to keep clear, neat notes which can be referred to in later years of the course as well as during the study of this unit. Well selected illustrations should be supplied by the teacher to illustrate the notes. These illustrations should be simple and in clear demonstration of the principle.	F9, F10. F11.

Basic Information	Operations and Projects	References

b. Area - Area is two dimensional, a surface, may have tones, textures and colors. It is bounded by contour or shape. It is shape.

Each student should also be required to amplify these illustrations with examples which he himself contributes.

c. Value - This is the quantity of light reflected by a surface. It may vary from total reflection (white) to no reflection (black). Both colors and neutral tones have value.
Neutral tones have value but no hue.

In this section of the work, illustrations and actual work by both teacher and student should be confined to the elements of line, area, value, and texture.

Examples to illustrate notes and assignments can be obtained from the problem sections of "Design Fundamentals" by Feldsted.

d. Texture- This is the quality of actual or simulated roughness or smoothness of a surface. Texture appeals to both the senses of touch and of sight.

e. Color - This is the quality of visible light reflected from a surface or subject which gives it hue. While this is one of the most important factors in design it is a complex one, and will be treated in later units of the course in design.

f. Space or volume - This implies the manipulation in design of solid subjects, three dimensional subjects and voids. This is one of the primary tools of architecture and of the sculptor. In drawing and painting, space is usually a simulated illusion as in perspective. As with color, this is one of the more difficult units of expression, and will be left for later treatment in the course.

Basic Information	Operations and Projects	References
6. Design Problems - The Line A minimum of six design problems shall be completed in this section. Each problem should be done reasonably quickly though the length and complexity can be increased with later problems. Careful consideration must be given by both teacher and student to obtaining harmony, contrast, balance and rhythm in each design. (These remarks apply for the following two sections of the work as well.)	The problems of "Division I" of "Design Problems" are suggested as exemplary of the sort of problem desired. While some definition of framework must be given to the problem, strong emphasis must be placed upon the necessity of the student creating his own design within this framework. The objective here, after all is to develop this creative ability in the student.	F12 to F29
7. Design Problems - Area and Value A minimum of six design problems which are ordered in difficulty and which emphasize consideration of design elements shall be completed in this section.	The problems of "Division II" of "Design Fundamentals" are suggested as exemplary.	F30 to F41
8. Design Problems - Texture A minimum of four design problems which are ordered in difficulty and which emphasize consideration of design elements shall be completed in this section.	The problems of "Division IV" of "Design Fundamentals" are suggested as exemplary.	F60 to F67

NOTES:

1. The order of complexity of the problems of Sections 6,7, and 8 should increase throughout the series. Care should be exercised that the problems do not become very complex and therefore tedious and difficult to criticise in clear-cut fashion.

2. Students and teachers are reminded that it is extremely important that all products of this unit be preserved and carried forward to the next year of the course.

3. It is suggested that the unit of work be suitably brought to a conclusion with a well displayed exhibition of work. (This device should also be employed on a class basis, on the completion of each problem for criticism and discussion purposes.)

UNIT IV - DETAIL AND ASSEMBLY DRAWINGS
(Suggested time - 40 hours)

Basic Information	Operations and Projects	References
A. Evolutions of Design	This information should be recorded in the students notes. It could be accompanied with an organizational diagram tracing the design from first concept to finished product.	G p. 395,494 F p.356,13-2
1. Need for object (market)		
2. Priced for market		
3. Idea sketches		Z p.248,13-1
4. Engineering considerations		
5. Design layout-empirical & scientific data. How drawn, scale, etc.		F p.355,13-1
6. Working drawings		
7. Models		
8. Prototype		
9. Revisions		
10. Production		
B. Working Drawings		
1. Definition	Memorize F&S, p.171,13.1	
2. Set of drawings, what they include	Students could make a set of drawings (see under details & assembly below)	F p.360;13-9 F p.355;13-1
3. Detail drawings		F p.358,13-4
a. Definition	Memorize F&S p.172,13-3	
b. Multiple drawing system	Students should draw plates involving single & multiple detail systems. These should tie in later with a subassembly or assembly drawing. There may be a project that will include a "set" of drawings, including details and assemblies. Problems may be selected from textbook. Students should thoroughly study French & Svensen, p.171 through 182 up to Para. 13-19.	G p.398,432
c. Single drawing system, why more widely used		G p.403,438
d. Simplified graphical symbols & conventions are sometimes used to speed up drafting time. Each company may have its own set of standards.		
4. Sub Assemblies & Assemblies		G p. 406,440
a. Function - To show the relative positions of detailed parts		Z p.249,13-2, 13-5;13-6;13-7, 13-8,13-9,13-10,13-11,13-12
b. Dimensions & notes required		
c. Detail omitted		
d. Treatment of standard parts		

Basic Information	Operations and Projects	References
5. Parts Lists, Bills of Materials, etc. a. Why necessary b. Calling up of parts on assembly & sub assembly drawings, use of "Balloons", etc. c. Order of calling up d. Calling up detail drawing numbers on assemblies e. Cross referencing drawing numbers-details to next assembly, etc. f. Where parts list placed on the drawing g. Calling up standard parts		G p. 401,435 F p.359,13.9 13.7 Z p.250,13-4
6. Title Blocks, Strips, etc. a. Reqd information b. Order of importance c. Drawing number		G. p.399,433 F p.364,13.15 Z p.250,13-3

UNIT V - DEVELOPMENTS AND INTERSECTIONS
(Suggested time - 15 hours)

Basic Information	Operations and Projects	References
A. Fabrication from flat stock by developing patterns to be folded or rolled and fastened. Compare above method with diestamping, shaping as in art metal, and metal spinning.		F&S pp.275-277
B. Methods or types of developments: 1. Parallel line method for prisms (objects that have uniform cross-section; edges or elements run parallel to each other) 2. Radial line method for right cones and pyramids. Patterns are developed as sectors of circles.	Illustrate by sketching examples of objects that would be developed by each method.	J&M Chapt. 10 (Jensen & Mason, "Drafting Fundamentals, 1963, McGH.) F&S Chapt. 20

Basic Information	Operations and Projects	References
3. Triangulation method for offset cones and pyramids, and for transition pieces connecting ducts of different cross-section.		
C. Development of patterns for prisms (including cylinders.) Layout procedure involving the use of orthographic views, identification of edges or elements, determining the "stretchout", and joining points on the pattern with straight edge or with irregular curves.	Problem assignments and drawings to develop patterns for lateral surfaces of prisms. Draw objects (one cylindrical) with truncated tops or bottoms to apply knowledge of auxiliary views to develop "lids". A drawing of a two piece, three piece or four piece elbow.	F&S pp.503-505 J&M p. 122 G p.381 F&S pp.280-281 J&M pp.122-123
D. Development of patterns for right cones and pyramids (radial line method) Finding true lengths (by revolution or diagram) of lines oblique to picture planes as required in these developments.	Problem assignments. Drawings to develop the lateral surface and "lid" of a truncated pyramid and a truncated cone.	F&S pp.282-284 F&S pp.505-506
E. Intersections	Problems and a drawing involving lines of intersection of prisms.	F&S pp.287-289 J&M pp.125-126
	Drawing involving intersection and development of cylinders in "T" or "Y" arrangement.	F&S p. 510 G pp.375-376
F. Triangulation	A drawing of the development of a transition piece to connect a square to a cylindrical duct.	F&S p. 514

BUILDING MATERIALS AND METHODS

The following units related to Building Construction are to be taught in the drafting room by the drafting instructor, and where applicable, related directly to architectural drawings. It is imperative that the drafting and the building construction instructors work in close harmony with each other in order that their students may obtain the greatest value from this theory and the practical aspects of Part II - Building Construction.

NOTE: This study should be limited to the more common materials of construction and should be concerned with information which will be most useful to a draftsman. Specific information regarding such things as nominal and actual sizes, grading, physical properties and structural attributes, etc., should be learned.

UNIT VI - MATERIALS

Basic Information	Operations and Projects	References
A. Wood - Common woods and their characteristics, seasoning, defects and blemishes, sizes, grades, common forms - strips, boards, dimension, heavy joists, siding, flooring shiplap and dressed and matched, board measure.	Study of wood samples and charts. Films.	A. Schwankl Identification of Wood - Canadian Lumberman's Assn. Mix and Cirou, B.C. Lumber Manufacturers' Assn. Standard Grading and Dressing Rules.
B. Plywoods - Firs and poplar, properties, advantages and disadvantages, grades, sizes, common uses - construction, cabinetwork, siding, sheathing, underlay.	Theory	
C. Fasteners - Nails and nail sizes; screws - sizes; material types; glues - types and uses.	Examine nails, screws, nail charts, screw charts.	Miller-Chapt.13 15,16 Hammond et al
D. Finishing Materials - abrasives, flint, garnet, aluminum oxide, steel wool, pumice stone, rotten stone, polishing compound, paints, lacquers, varnishes, sealers, stains, fillers, thinners and solvents; purposes of finishing and common methods.	Examine materials and finished wood samples. Theory	Norton and Behr Manning Inst. Manuals Holtrop and Hjorth

Basic Information	Operations and Projects	References
E. Hardware - hinges, locks, stops, bolts, catches, pulls, garage door hardware, sash hardware, tracks.	Study samples and catalogues.	Stanley catalogue #81. Miller - Chapt. 24
F. Concrete - definition, characteristics, mass concrete, reinforced concrete, matrix, aggregates, grading and sizing of aggregates, admixtures, proportioning, mixing procedure, pouring, vibrating, joints, finishing procedures, curing, strengths, forms, concrete blocks.	Films Field trips and reports	Canada Cement Co. Ltd. - information booklets and technical data. Steinberg and Stempel Ron C. Smith

UNIT VII - HAND TOOLS

Basic Information	Operations and Projects	References
A. Cutting Tools - saws, chisels, hatchets, axes, planes, scrapers. B. Measuring Tools - rules and tapes. C. Layout and marking tools - framing square, try square, combination square, sliding T-level, dividers, scribers, marking gauge, mortise gauge, butt gauge, marking knife, trammel points, straight edge.	Theory only Recognition, description, care and use of each.	Principles and Practices of Light Construction - R. C. Smith R. C. Smith

Basic Information	Operations and Projects	References
D. Boring tools - bits and drills, countersinks, depth gauge, bit brace, hand drill, push drill, twist drills - operations performed with each.	Theory	Ron C. Smith
	Films	Wilson
E. Assembling tools - hammers, screwdrivers, nail sets, wrenches.		
F. Leveling and Plumbing Tools - spirit level, line level, level sights, plumb bob, builder's level.		Ron C. Smith
G. Holding tools - C - clamps, bar and pipe clamps, adjustable hand screws, and woodworkers vises.		Ron C. Smith

UNIT VIII - POWER TOOLS

Basic Information	Operations and Projects	References
A. Portable Electric Power Tools - hand electric saw, belt sander, orbital sander, electric drills, router, saber saw, electric plane.	Theory only Description, and operationn performed.	Ron C. Smith
B. Stationary Power Tools Table saw, radial arm saw, bandsaw, thickness planer, jointer, shaper, mortiser.	Description and operations performed.	Delta "How To" books Hammond et al

UNIT IX - THE FOUNDATION

Basic Information	Operations and Projects	References
A. Footings - purposes, sizes, materials, depth, connection with foundation, post footings, bearing wall footings, soils for footings.	Complete section drawings. Study working drawings.	Wilson
B. Foundation Walls - size, materials, framing of openings, form construction, mud sills.	Films Field trip	Ron C. Smith C.M.H.C. Housing Standards
C. Basement Floor - size, material, base material, framing of openings, forms and placing		

UNIT X - FLOOR FRAMING

Basic Information	Operations and Projects	References
A. Bearing Elements - posts, bearing partitions, beams - types, and construction, materials and joining methods.	Section and elevation drawings.	
B. Sill Construction - box sill, cast-in joists. Joists - size, maximum span, spacing, material, hangers, bridging, subfloor.	Theory. Section drawings. Study models. Field trips.	Ron C. Smith "Framing, Sheathing and Insulation" - Delmar Publication C.M.H.C. Standards

UNIT XI - WALL FRAMING

Basic Information	Operations and Projects	References
A. Framing Systems - western or "platform" framing, post and beam framing.		Ron C. Smith
B. Wall construction - studs; plates, headers, cripples, sills, corner posts, partition posts, window and door openings, sheathing, bracing.	Examine materials, specifications, standards. Orthographic and section drawings.	"Framing, Sheathing and Insulation"- Delmar Publication. Wilson

UNIT XII - CEILING FRAMING

Basic Information	Operations and Projects	References
Joists - sizes, spacing, framing of openings, ceiling, backing, joist hangers.	Study working drawings.	Ron C. Smith

UNIT XIII - ROOF FRAMING

Basic Information	Operations and Projects	References
A. Roof Shapes - shed, gable, hip, gambrel and intersecting roofs, flat roofs.	Theory only	Ron C. Smith
B. Roof Framing Terms 1. rafters - common, hip, jack, valley, cripple jacks, valley jacks.		
2. rafter terms - span, run, unit run, unit span, unit rise, pitch, birdsmouth, seat cut, plumb cut, check cut, overhang, backing, dropping, true length and shortening.	Theory and field trips.	Ron C. Smith Wilson
3. Framing Terms - purlin; strongback, collar tie, ridge board.	Make rafter calculations and estimate material for roofs.	
C. Roof Sheathing and Decking - materials, coverage.		

UNIT XIV - OTHER ROOF SYSTEMS

Basic Information	Operations and Projects	References
A. Trusses - terminology, types. B. Rigid Frame Construction C. Glue Laminated Arches		Ron C. Smith

UNIT XV - EXTERIOR FINISHING

Basic Information	Operations and Projects	References
A. Cornice Construction - open cornice, box cornice, terminology.	Section drawings	
B. Roofing Materials - rolled roofing, shingles, roofing tile, sheet metal, plastic, built up roofing, advantages, estimating costs.		Ron C. Smith
C. Exterior Wall Cladding - sheathing, papers, siding materials	Estimating quantities	
D. Finishing of Openings - installation of window frames and sash installation of door frames, (standard detail s for wooden sash and door frames only should be dealt with.	Orthographic and section drawings.	Mix and Cirou
E. Flashing of Openings - Chimney, valley, siding divisions, doors and windows; materials and methods.		

UNIT XVI - INTERIOR FINISHING

Basic Information	Operations and Projects	References
A. Insulation - bolts, rigid board, loose fill - materials, purpose, method of installing.		Ron C. Smith
B. Wall and Ceiling finish - plaster, plaster board, ten-test, common synthetic boards, wood trims, veneers and plywoods, tile, plastic laminates - where used and method of application.	Theory	Mix and Cirou Wilson
C. Flooring - T & G softwoods and hardwoods, roll coverings, tile-properties, where used, method of application.		
D. Stair Construction - open notched stringers, housed stringers, concrete stairs, riser-tread design, headroom and clearance.	Check standards. Study working drawings and sections.	Ron C. Smith C.M.H.C. Housing Standards
E. Cabinets - kitchen cabinets, construction details, estimating.		

REFERENCES

Canadian Lumbermen's Association, "Identification of Woods".

Mix and Cirou, "Practical Carpentry", General Publishing Co.

Schwankl, "What Wood is That?", Longman's Green and Co.

British Columbia Lumber Manufacturers' Association, "Standard Grading and Dressing Rules".

Miller, "Hand and Machine Woodwork", MacMillan of Canada.

Hammond, Donnelly, Harrod, Rayner, "Woodworking Technology", General Publishing Co.

Holtrop and Hjorth, "Principles of Woodworking", Bruce Publishing Co.

Steinberg and Stempel, "Practices and Methods of Construction", Prentice-Hall.

Ronald C. Smith, "Principles and Practices of Light Construction", Prentice-Hall.

Delta Manufacturing Co., "How to Get the Most Out of Your Circular Saw & Jointer.

Central Mortgage and Housing Corporation, "Housing Standards".

"Framing, Sheathing and Insulation", (Delmar Publication), Thomas Nelson & Sons.

J. Wilson, "Practical House Carpentry", McGraw-Hill.

PART TWO - BUILDING CONSTRUCTION

(Time - 5 credits)

Purpose

This unit is intended to develop a practical knowledge of building construction principles, methods and materials essential to the draftsmen who will be planning and producing working drawings for such structures.

Method of Approach

It is expected that the student will attain this knowledge through the experience of making these constructions or models of them in a practical shop situation. Emphasis should be placed on the correct procedures for combining building materials to form a structure with accent being placed upon a knowledge of existing common systems and building materials.

It is intended that the student should achieve a practical understanding of the function, capabilities, and limitations of the basic hand and machine tools of construction. The development of a high degree of skill in their use is not an objective but an appreciation of craftsmanship should be developed.

It is imperative that the building construction and the drafting instructors work in close harmony with each other, in order that their students may obtain the greatest value from the theory as taught by the drafting instructor, and the practical aspects of the following units. The instructor in the shop should be aware that the drafting instructor is covering most of the theory and should therefore place the emphasis on practical experiences. Each portion should reinforce and give meaning to the other.

UNIT I - SHOP ORIENTATION

Basic Information	Operations and Projects	References
A. Orientation - shop procedure, regulations, forms, tools and machines, attitudes, discipline.	Tour the shop facilities explaining the use of tools and equipment in general.	
B. Shop Safety (to be stressed continually throughout the course)	Draw attention to hazardous equipment and the need for strict observance of regulations.	

Basic Information	Operations and Projects	References
A. Care, adjustment and proper use of the following tools:	Demonstrate tools as required for use.	
1. Measuring tools - rules and tapes.		
2. Layout and marking tools - framing square, try square, combination square, sliding T-level, dividers, scriber, marking gauge, mortise gauge, butt gauge, marking knife, trammel points, straight edge.		Miller Holtrop & Hjorth
3. Cutting tools - ripsaw, crosscut saw, compass saw, backsaw, coping saw, chisels, hatchets, axes, planes-jointer, fore, jack, smooth, block, bull-nose cabinet and special planes.	Cut out rough stock; square up stock; layout and make the following wood joints: dado, cross lap, corner lap, open mortise and tenon, mitre.	Wilson
4. Boring Tools - bits and drills, countersinks, depth gauge, bit brace, hand drill, push drill, twist drills.	Exercises and projects should be selected in keeping with the tools to be learned as well as the joints and operations.	Ron C. Smith
5. Assembling Tools - hammers, screwdrivers, nail sets, wrenches.		
6. Leveling and plumbing tools - spirit level, line level, level sights, plumb bob, builder's level.	Introduce and demonstrate as required in the program.	Ron C. Smith
7. Holding tools - C-clamps, bar and pipe clamps, adjustable hand screws, and woodworkers vises.		
B. Finishing Materials - abrasives - flint, garnet, aluminum oxide, steel wool, pumice stone, rotten stone, polishing compounds, paint lacquers, varnishes, sealers stains, fillers.	Demonstration and outlining the purpose is all that is necessary here.	Holtrop and Hjorth
C. Hardware - common types	Apply hardware such as locks and hinges.	

UNIT III - MACHINE WOODWORKING TOOLS

Basic Information	Operations and Projects	References
A. Correct methods of use, adjustment, safety and capabilities of the following woodworking machines:		
1. Circular Saw (table and radial arm)	Ripping, crosscutting, level cutting, dadoing and grooving operations on suitable projects and models.	Delta books Miller
2. Jointer	Face and edge jointing, dressing procedure in conjunction with other machines, level jointing, chamfering and rabbeting.	Holtrop & Hjorth
3. Thickness planer -- emphasizing the orderly routine to be followed in machine dressing of lumber.	Dressing lumber to size in conjunction with the circular saw and jointer.	

UNIT IV - JOINERY

Basic Information	Operations and Projects	References
A. Types of joints, method of construction and uses.	Construction of the following joints - dado, rabbet, tongue and groove, half lap, miter.	Stanley Tool Guide. Holtrop & Hjorth
B. Cabinet Construction	Cabinet construction such as shelves, drawers, doors and surfacing of basic contemporary systems.	Hammond et al Ron C. Smith Holtrop & Hjorth

Basic Information	Operations and Projects	References
A. Site and Foundation 1. location, contour, types of soil, services. 2. locating property corner stakes, locating the building corners, batter boards. 3. foundation types, footing forms and foundation forms, bracing, ties, openings.	Field trips to study lot layout, building lines, levels, footings, foundation walls, post footings and posts; concrete forms, mixing, placing, finishing and curing of concrete.	Ron C. Smith Mix and Cirou Wilson
B. Floor Framing Methods 1. western or "platform" framing. 2. post and beam	Some students may complete minimalic construction of floor framing, full scale framing of typical sections or full scale construction of small buildings.	Ron C. Smith
C. Systems of Frame Construction (Contemporary methods of framing only)	Have students perform plate layouts on 2 x 4's indicating corner and partition posts, allowances for doors and window openings. Framewall sections, make a story rod.	
D. Roof Framing Methods 1. Roof shapes - shed, gable, hip, gambrel, intersecting and flat roofs.	Students layout rafter problems on 2" x 4", involving common, hip and valley rafters. Calculate material required for roofs. Student may construct scaled down door and window frames using full size stock. Field strips to study framing methods and materials.	Wass and Sanders Ron C. Smith

Basic Information	Operations and Projects	References
E. Stair Construction		
1. Parts of a stair stringer, tread, riser, cant strips, handrail, newel post, balustrade.	Layout only, on full size stock, stair stringers for both open and housed stairs.	Ron C. Smith
F. Exterior finishing		
1. Cornice construction	Where small buildings are being constructed, students may complete the cornice construction; field trips to examine other types.	Wilson
2. Roofing materials and methods		Mix and Cirou
3. Exterior wallcladding, and openings		Ron C. Smith

REFERENCES

H. G. Miller - "Hand and Machine Woodwork", MacMillan of Canada.

Holtrop and Hjorth - "Principles of Woodworking", Bruce Publishing Co.

J. Douglas Wilson - "Practical House Carpentry", McGraw-Hill Book Co.

Ron C. Smith "Principles and Practices of Light Construction", Prentice-Hall.

Stanley Tool Guide - "Stanley Tools", New Brittain, Conn.

Mix and Cirou - "Practical Carpentry", General Publishing Co.

Wass and Sanders - "Building Construction - Roof Framing", Prentice-Hall.

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